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(71) Applicant: **NTN CORPORATION**
Osaka-shi, Osaka 550-0003 (JP)

(72) Inventors:
- **Kobayashi, Masazumi**
  Iwata-shi
  Shizuoka-ken (JP)
- **Nakagawa, Tohru**
  Iwata-shi
  Shizuoka-ken (JP)
- **Kobayashi, Tomoshige**
  Iwata-shi
  Shizuoka-ken (JP)
- **Nakamura, Masamichi**
  Iwata-shi
  Shizuoka-ken (JP)

(74) Representative: **White, Duncan Rohan**
Marks & Clerk
90 Long Acre
London WC2E 9RA (GB)

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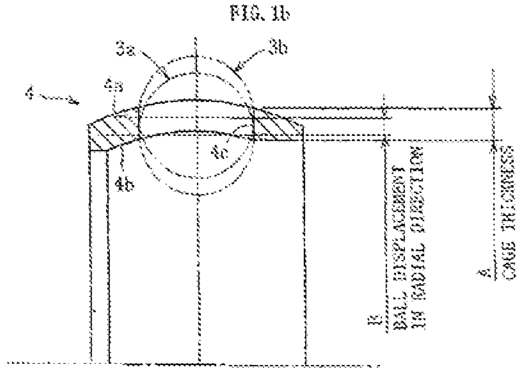
(54) **Fixed type constant velocity universal joint**

(57) There is provided a fixed type constant velocity universal joint comprising an outer joint member (1) having eight arcuate guide grooves (1b) extending in the axial direction in an inner spherical surface (1a) thereof, an inner joint member (2) having eight arcuate guide grooves (2b) extending in the axial direction in an outer spherical surface (2a) thereof, eight balls (3) disposed between the guide grooves (1b) of the outer joint member (1)and guide grooves (2b) of the inner joint member (2), and a cage (4) interposed between the outer joint member (1) and inner joint member (2) for retaining the balls (3). The center (P) of guide grooves (1b) of the outer joint member (1) is offset from the center (O) of the inner spherical surface (1a), and the center (Q) of the guide grooves (2b) of the inner joint member (2) is offset from the center (O) of the outer spherical surface (2a) by equal distance (F) to opposite sides in the axial direction. The constant velocity joint is an undercut free type constant velocity joint and the relationship 0.65 <= B/A <= 0.85 is established, where A stands for the wall thickness of the cage (4), and B the radial displacement of balls (3) at maximum joint angle.

FIG. 1b



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a constant velocity universal joint used in power transmission in automobiles and various industrial machines, and more particularly to a fixed type constant velocity universal joint having eight balls.

Prior Art

[0002] Constant velocity universal joints are classified into a fixed type not sliding in the axial direction, and a slidable type. Figs. 8a and 8b show a Rzeppa type constant velocity universal joint (hereinafter called BJ type) as a representative example of fixed type constant velocity universal joint. This constant velocity universal joint comprises an outer ring 11 as an outer joint member having six arcuate guide grooves 11b extending in the axial direction in an inner spherical surface 11a, an inner ring 12 as an inner joint member having six arcuate guide grooves 12b extending in the axial direction in an outer spherical surface 12a, six balls 13 disposed between the guide grooves 11b of the outer ring 11 and guide grooves 12b of the inner ring 12, and a cage 14 for retaining the balls 13.

[0003] Centers P and Q of the guide grooves 11b and 12b are offset from the joint center O by an equal distance (PO = PQ) to the right and left side in the axial direction. That is, the center P of guide groove 11b of the outer ring 11 is offset from center O of the inner spherical surface 11a to the opening side of the outer ring 11 by distance PO. The center Q of guide groove 12b of the inner ring 12 is offset from center O of the outer spherical surface 12a to the inner side of the outer ring 11 by distance QO. The centers of inner spherical surface 11a of the outer ring 11 and outer spherical surface 12a of the inner ring 12 coincide with the joint center O.

[0004] One (not shown) of two shafts to be coupled is connected to the outer ring 11, and other (shaft part 15) is connected to the inner ring 12. Accordingly, the inner ring 12 has a tooth profile, i.e. serration or spline, 12c to be coupled with the shaft part 15. The outer ring 11 and inner ring 12 form a certain angle, and the balls 13 guided in the cage 14 are maintained within a plane perpendicular to a bisector of angle θ formed by the outer and inner ring 11 and 12, so that the constant velocity of the joint is assured.

[0005] In a fixed type constant velocity universal joint, hitherto, a constant velocity universal joint applicable to high angle (maximum joint angle 50°) was an undercut-free joint (called UJ type) comprising six balls 13, but by increasing the number of balls and reducing the ball diameter, a more compact UJ type having eight balls with same strength and durability has been developed (for example, see Japanese Patent Application laid-open under No. H9-317784).

SUMMARY OF THE INVENTION

[0006] In a fixed type constant velocity universal joint, when torque is transmitted in a state of forming a working angle, in the cage pockets, the balls move in the circumferential direction, and also move in the radial direction at the same time (see Fig. 1). In the conventional fixed type constant velocity universal joint of six balls, the wall thickness of the cage has been determined to set the minimum limit to satisfy the displacement of balls in the radial direction at the maximum joint angle, in other words, so that the ball contact point may settle within the cage pocket. This is because increase of wall thickness of the cage causes the depth of guide grooves in the outer and inner rings to be reduced, thereby lowering the durability life of the joint at high angle and high load.

[0007] In the fixed type constant velocity universal joint of eight torque transmission balls realizing a more compact design and lighter weight, it is important that the strength at high joint angle should be kept same as that of the conventional constant velocity universal joint of six balls. To increase the strength of the cage, it is easy to increasing the wall thickness of the cage, but by increasing the thickness of the cage, the depth of the guide grooves of the outer and inner rings becomes shallower. As the guide grooves of the outer and inner rings become shallow, contact ellipses of balls can ride over the guide grooves at high angle and high torque load, and the durability life is lowered.

[0008] It is hence an object of the invention to present a fixed type constant velocity universal joint of eight balls capable of satisfying two important functions, that is, assurance of cage strength at high angle and assurance of durability life at high angle and high torque load.

[0009] It is other object of the invention to present a fixed type constant velocity universal joint of eight balls seeking the optimum thickness of cage in order to have the cage strength at high angle and durability life at high angle and high load equivalent to that of the conventional fixed type constant velocity universal joint of six balls.

[0010] It is one aspect of the invention to present a fixed type constant velocity universal joint comprising an outer joint member having eight arcuate guide grooves extending in the axial direction in an inner spherical surface, an inner joint member having eight arcuate guide grooves extending in the axial direction in an outer spherical surface, eight

balls disposed between the guide grooves of the outer joint member and guide grooves of the inner joint member, and a cage interposed between the outer joint member and inner joint member for retaining the balls, in which center of guide grooves of the outer joint member is offset from center of inner spherical surface, and center of guide grooves of the inner joint member is offset from center of outer spherical surface by equal distance to opposite sides in the axial direction, and the relation of $0.45 \leq B/A \leq 0.65$ is established, where A stands for the wall thickness of the cage, and B the radial displacement of balls at maximum joint angle.

[0011] It is other aspect of the invention to present a fixed type constant velocity universal joint comprising an outer joint member having eight arcuate guide grooves extending in the axial direction in an inner spherical surface, an inner joint member having eight arcuate guide grooves extending in the axial direction in an outer spherical surface, eight balls disposed between the guide grooves of the outer joint member and guide grooves of the inner joint member, and a cage interposed between the outer joint member and inner joint member for retaining the balls, in which center of guide grooves of the outer joint member is offset from center of inner spherical surface, and center of guide grooves of the inner joint member from center of outer spherical surface, by equal distance to opposite sides in the axial direction, and inner spherical surface of the cage is offset from outer spherical surface thereof to the opposite side by equal distance in the axial direction, and further straight portions having straight groove bottoms are provided in guide grooves of the outer joint member and inner joint member, and the relation of $0.65 \leq B/A \leq 0.85$ is established, where A stans for the wall thickness of the cage, and B the radial displacement of balls at maximum joint angle.

[0012] Value R1 of ratio (F/PCR) of offset amount F to length PCR of line segment linking center of guide grooves of the outer joint member or center of guide grooves of the inner joint member and center of balls may be specified in a range of $0.069 \leq R1 \leq 0.121$.

[0013] Contact angle α of guide grooves and balls may preferably be in a range of 29° to 40°. When the offset amount F is decreased, the inversion start angle of wedge angle between guide grooves of the outer joint member and inner joint member becomes smaller, and when the wedge angle is inverted, the play of the balls in the guide grooves is increased, and hammering sound can be generated. Accordingly, to set the wedge angle inversion start angle at least more than the ordinary angle of vehicle or the like, the contact angle α of guide grooves and balls is set in a range 29° to 40°. Herein, the wedge angle refers to the angle formed by a common normal of load side contact point of balls and guide grooves of outer joint member, and a common normal of load side contact point of balls and guide grooves of inner joint member. The ordinary angle of vehicle is generally 9° or less. As the joint angle increases, the wedge angle comes to the minus side going down below zero. This change of sign of wedge angle below zero is called inversion of wedge angle.

[0014] The following table shows the relation of the value R1 of ratio (F/PCR) of offset amount F to length PCR of line segment linking center of guide grooves of the outer joint member or center of guide grooves of the inner joint member and center of balls, contact angle α, and wedge angle inversion start angle.

Table 1

Value of ratio F/PCR	Contact angle α (°)	Inversion start angle of wedge angle (°)
0.069	45	8
	40	9
	29	14
0.121	45	14
	40	16
	29	25

[0015] As known from Table 1, the smaller the contact angle α, the larger becomes the wedge angle inversion start angle. Also, the larger the offset amount F, the larger becomes the wedge angle inversion start angle. Therefore, as in the configuration described above, by setting the value R1 of ratio (F/PCR) of offset amount F to length PCR of line segment linking center of guide grooves of the outer joint member or center of guide grooves of the inner joint member and center of balls in a range of $0.069 \leq R1 \leq 0.121$, and specifying the contact angle α of guide grooves and balls in a range of 29 degrees to 40 degrees, the contact ellipse of balls will not be dislocated from the guide grooves to ride over the spherical surface, and at least at the joint angle smaller than the ordinary joint angle of vehicle, play of balls in the guide grooves is eliminated, generation of hammering sound is prevented.

[0016] The fixed type constant velocity universal joint of the invention assures the specified thickness of the cage, and realizes a more lightweight and compact structure while having the durability life and high angle strength equivalent to that of the conventional fixed type constant velocity universal joint of six balls.

[0017] Referring now to the drawings, preferred embodiments of the invention will be described.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

Fig. 1a is a longitudinal sectional view of a joint for explaining the structure of the invention;
Fig. 1b is a sectional view of a cage;
Fig. 2a is a longitudinal sectional view of joint according to an embodiment of the invention;
Fig. 2b is a cross-sectional view of the joint shown in Fig.2a;
Fig. 3 is a partial, magnified view of Fig. 2a;
Fig. 4 is a partial, magnified view of Fig. 2b;
Fig. 5 is a partial, magnified view of Fig. 3;
Fig. 6 is a longitudinal sectional view of a joint according to other embodiment;
Fig. 7 is a diagram showing the relation of cage strength and allowable load torque in terms of wall thickness of cage;
Fig. 8a is a longitudinal sectional view of a conventional fixed type constant velocity universal joint; and
Fig. 8b is a cross-sectional view of the joint shown in Fig. 8a.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0019] First, an embodiment of BJ type shown in Figs. 2a, 2b and Fig. 3 is explained. Fig. 2a is a longitudinal sectional view of a joint, and Fig. 2b is a cross-sectional view of the joint. Fig. 3 is a partial, magnified view of Fig. 2a.

[0020] As shown in Figs. 2a, 2b and 3, the fixed type constant velocity universal joint is mainly composed of an outer ring 1, an inner ring 2, balls 3, and a cage 4. The outer ring 1 as outer joint member is formed like a cup, and a shaft part for connecting with one of two shafts to be coupled is formed at the closed end side thereof. The outer ring 1 has a spherical inner circumference, that is, an inner spherical surface 1a, and eight arcuate guide grooves 1b extending in the axial direction are formed in the inner spherical surface 1a. The inner ring 2 as inner joint member has a tooth profile, i.e. serration or spline, 2d to be connected with other one (shaft part 5) of two shafts to be coupled. The inner ring 2 has a spherical outer circumference, that is, an outer spherical surface 2a, and eight arcuate guide grooves 2b extending in the axial direction are formed in the outer spherical surface 2a. The guide grooves 1b of the outer ring 1 and guide grooves 2b of the inner ring 2 form pairs, and one ball is disposed in a ball track formed by each pair of guide grooves 1b and 2b. A total of eight balls 3 are retained at equal intervals in the circumferential direction by the cage 4. The cage 4 has concentric outer and inner spherical surfaces 4a and 4b, and the outer spherical surface 4a spherically contacts the inner spherical surface 1a of the outer ring 1, and the inner spherical surface 4b spherically contacts the outer spherical surface 2a of the inner ring 2.

[0021] In this embodiment, centers P and Q of the guide grooves 1b and 2b are respectively offset from joint center O by equal distance (PO = QO = F) to the right and left side in the axial direction. That is, the center (outer ring track center) P of guide grooves 1b of the outer ring 1 is offset from the center O of the inner spherical surface 1a to the opening side of the outer ring 1 by distance PO. The center (inner ring track center) Q of guide grooves 2b of the inner ring 2 is offset from the center O of the outer spherical surface 2a to the inner side of the outer ring 1 by distance QO. The center of the outer spherical surface 4a of the cage 4, and the center of the inner spherical surface 1a of the outer ring 1 as the guide surface of the outer spherical surface 4a of the cage 4 both coincide with the joint center O. Similarly, the center of the inner spherical surface 4b of the cage 4, and the center of the outer spherical surface 2a of the inner ring 1 as the guide surface of the inner spherical surface 4b of the cage 4 both coincide with the joint center O. Therefore, the offset amount (PO = F) of the outer ring 1 is the axial distance between the center P of the guide grooves 1b and the joint center O, and the offset amount (QO = F) of the inner ring 2 is the axial distance between the center Q of the guide grooves 2b and the joint center O, and the both are equal to each other.

[0022] Length PO_3 of line segment linking center P of guide grooves 1b of outer ring 1 and center O_3 of ball 3, and length QO_3 of line segment linking center Q of guide groove 2b of inner ring 2 and center O_3 of balls 3 are equal to each other, as indicated by PCR in Fig. 2a. Further, as shown in Fig. 3, an angle formed between the line segment linking center P of guide grooves 1b of outer ring 1 and center O_3 of ball 3, and the line segment linking joint center O and center O_3 of balls 3 is called outer ring track offset angle βo, and an angle formed between the line segment linking center Q of guide grooves 2b of inner ring 2 and center O_3 of ball 3, and the line segment linking joint center O and center O_3 of balls 3 is called inner ring track offset angle βi, and the outer ring track offset angle βo and inner ring track β1 are equal to each other.

[0023] In this configuration, one (not shown) of two shafts to be coupled and outer ring 1 are connected, and other (shaft part 5) and inner ring 2 are connected. When the outer ring 1 and inner ring 2 form a certain angle, the balls 3 guided in the cage 4 are maintained within a plane perpendicular to a bisector of angle θ formed by the outer and inner

rings 1 and 2, and therefore the distances PO_3 and QO_3 from the ball center O_3 to the guide groove centers P and Q are equal to each other ($PO_3 = QO_3 = PCR$), so that the constant velocity of the joint is assured.

[0024] As described above, the offset amount (F = PO = QO) of the guide grooves 1b and 2b is set in range of value R1 of ratio F/PCR of $0.069 \leq R1 \leq 0.121$, and it is preferred from the viewpoint of assuring the allowable load torque, assuring the cage strength, assuring the durability, and assuring the working efficiency, and in this embodiment, the ratio is set at R1 = 0.104 (or 0.1038). In a comparative example (fixed type constant velocity universal joint of six balls as shown in Fig. 8), a general value of R1 is 0.14, and R1 of the embodiment is considerably smaller than in the comparative example.

[0025] FIG. 4 is a partial, magnified view of Fig. 2b, showing a mutual relation of outer ring 1, inner ring 2, and balls 3. Guide grooves 1b formed in the inner spherical surface 1a of the outer ring 1 have a Gothic arch cross section, and guide grooves 2b formed in the outer spherical surface 2a of the inner ring 2 have also a Gothic arch cross section. Therefore, the balls 3 contact the guide grooves 1b of the outer ring 1 at two points C_{11} and C_{12}, and contact guide grooves 2b of the inner ring 2 at two points C_{21} and C_{22}. Angle α formed by center O_3 of balls 3 corresponding to line segment passing the center O_3 of balls 3 and joint center O and contact points C_{11}, C_{12}, C_{21}, C_{22} with guide grooves 1b and 2b is the contact angle. Contact angles α of contact points C_{11}, C_{12}, C_{21}, C_{22} are all equal to each other, and set in a range of 29° to 40°. The contact angle α of 29° to 40° is smaller as compared with 37° to 45° in the conventional undercut-free joint of six balls, fixed type joint of six balls or fixed joint of eight balls. By setting the contact angle α at 29° or more, the contact surface pressure of the guide grooves and balls can be suppressed, and the durability equivalent to the prior art can be obtained.

[0026] Fig. 5 is a magnified view in part of Fig. 3 for explaining the inversion start angle of wedge angle. As mentioned above, the angle formed by common normal H_1 of contact point C_1 of balls 3 and guide grooves 1b of outer ring 1, and a common normal H_2 of contact point C_2 of balls 3 and guide grooves 2b of inner ring 2 is called the wedge angle 2τ. The common normal H_1 is a three-dimensional straight line linking the contact point of outer ring 1 and balls 3 and ball center O_3. Similarly the common normal H_2 is a three-dimensional straight line linking the contact point of inner ring 2 and balls 3 and ball center O_3. As shown in Fig. 5, contact point C_1 of guide grooves 1b of outer ring 1 and balls 3 is inclined to the joint center surface passing through center O_3 of balls 3 by angle τ owing to the arcuate guide grooves 1b. Similarly, contact point C_2 of guide grooves 2b of inner ring 2 and balls 3 is inclined to the joint center plane passing through center O_3 of balls 3 by angle τ owing to the arcuate guide grooves 2b. The wedge angle is equal to the sum 2τ of these wedge angles τ. The wedge angle 2τ decreases in a certain phase along with increase of joint angle, and is then inverted. The joint angle upon start of inversion of wedge angle 2τ is set at 9° or higher.

[0027] Fig. 6 shows an embodiment of UJ type. This embodiment is same as the embodiment in Fig. 1 except that a straight portion 1c is provided in the guide grooves 1b of the outer ring 1c, that a straight portion 1c is provided in the guide grooves 2b of the inner ring 2, and that the spherical centers p and q of the outer spherical surface 4a and inner spherical surface 4b of the cage 4 are offset in the opposite directions by equal distance f in the axial direction.

[0028] Referring back to Figs. 1a and 1b, in the fixed type constant velocity universal joint of eight balls, the cage strength at high angle and durability life at high angle and high load are compared with the conventional fixed type constant velocity universal joint of six balls, and the optimum value of the cage wall thickness for achieving the equivalent performance is explained. In Fig. 1a, the joint in Fig. 2a has the maximum joint angle θmax. The ball appearing at the upside in the drawing is indicated by reference numeral 3a, and the phase of this ball 3a is the phase of the ball coming to the innermost side of the cage. The ball appearing at the downside in the drawing is indicated by reference numeral 3b, and the phase of this ball 3b is the phase of the ball coming to the outermost side of the cage. Fig. 1b shows the balls 3a and 3b by double dot chain line in the longitudinal sectional view of the cage 4, in which the distance between centers of ball 3a and ball 3b indicated by character B is the radial displacement of the ball in the pocket 4c of the cage 4. The wall thickness of the cage 4 is the radial dimension of the peripheral wall of the pocket 4c, and it is indicated by character A in Fig. 1b.

[0029] Supposing the wall thickness of the cage 4 to be A and the radial displacement of the ball 3 in one revolution of the joint to be B, the wall thickness A of the cage 4 is defined to satisfy the range of $0.45 \leq B/A \leq 0.65$ in the BJ type, and satisfy the range of $0.65 \leq B/A \leq 0.85$ in the UJ type. The optimum value range of wall thickness of cage differs between the BJ type and UJ type because, as already explained in relation to Fig. 6, the UJ type has straight portions 1c and 2c in the guide grooves 1b and 2b of the outer and inner rings, and the guide grooves are shallower at the joint inner side as compared with the BJ type.

[0030] The meaning of this numerical value range is illustrated in Fig. 7. In Fig. 7, the numerical values refer to the BJ type, but a similar tendency is noted in the UJ type, too. In the diagram, T100 torque is a basic torque used in life calculation of constant velocity universal joint, and is the torque value determined from the contact stress (Hertz stress) of the guide grooves and balls of the outer ring and inner ring, and it means the torque capable of obtaining a life of 1500 hours at 100 rpm. As shown in Fig. 7, at $B/A < 0.45$, in other words, when the cage wall thickness A is larger more than necessary than the radial displacement B of the balls 3 in the pocket 4c of the cage 4, a sufficient strength of the cage 4 is assured, but the guide groove depth (inner side) of the inner and outer rings is too shallow, and the contact

ellipse of the balls 3 can go out of the guide grooves at maximum joint angle, and the load torque is lowered extremely, and the joint function can be lost. On the other hand, at B/A > 0.65, in other words, when the cage wall thickness A is not sufficient as compared with the radial displacement B of the balls 3 in the pocket 4c of the cage 4, the guide groove depth (inner side) of the inner and outer rings is sufficient, and the contact ellipse of the balls 3 will not go out of the guide grooves. To the contrary, the wall thickness A of the cage 4 is not enough, and the cage strength at high angle cannot be assured. In the UJ type having eight balls, a similar tendency as in the BJ type is noted. Since the structure is thus different, the numerical value range is also different.

[0031] Thus, in order to satisfy the both important properties of cage strength at high angle and joint durability at high angle, an optimum wall thickness setting of the cage is required, and the range is as specified above ($0.45 \leq B/A \leq 0.65$ in the BJ type, and $0.65 \leq B/A \leq 0.85$ in the UJ type).

Claims

1. A fixed type constant velocity universal joint comprising:

an outer joint member (1) having eight arcuate guide grooves (1b) extending in the axial direction in an inner spherical surface (1a) thereof,
an inner joint member (2) having eight arcuate guide grooves (2b) extending in the axial direction in an outer spherical surface (2a) thereof,
eight balls (3) disposed between the guide grooves (1b) of the outer joint member (1) and guide grooves (2b) of the inner joint member (2), and
a cage (4) interposed between the outer joint member (1) and inner joint member (2) for retaining the balls (3), wherein center (P) of guide grooves (1b) of the outer joint member (1) is offset from the center (O) of the inner spherical surface (1a), and the center (Q) of the guide grooves (2b) of the inner joint member (2) is offset from the center (O) of the outer spherical surface (2a) by equal distance (F) to opposite sides in the axial direction, **characterized in that** constant velocity joint is an undercut free type constant velocity joint and the relationship $0.65 <= B/A <= 0.85$ is established, where A stands for the wall thickness of the cage (4), and B the radial displacement of balls (3) at maximum joint angle.

2. The fixed type constant velocity universal joint of claim 1, wherein the inner spherical surface (4b) of the cage (4) is offset from outer spherical surface (4a) thereof to the opposite side by equal distance (f) in the axial direction, and that straight portions having straight groove bottoms are provided in guide grooves (1b, 2b) of the outer joint member (1) and inner joint member (2).

3. The fixed type constant velocity universal joint of claim 1 or 2, **characterized in that** value R1 of ratio (F/PCR) of offset amount (F) to length (PCR) of line segment linking center (P) of guide grooves (1b) of the outer joint member (1) or center (Q) of guide grooves (2b) of the inner joint member (2) and center (O_3) of the balls (3) is specified in a range of $0.069 <= R1 <= 0.121$.

4. The fixed type constant velocity universal joint of claim 1 or 2, **characterized in that** contact angle of guide grooves (1b, 2b) and balls (3) is in a range of 29° to 40°.

FIG. 1a

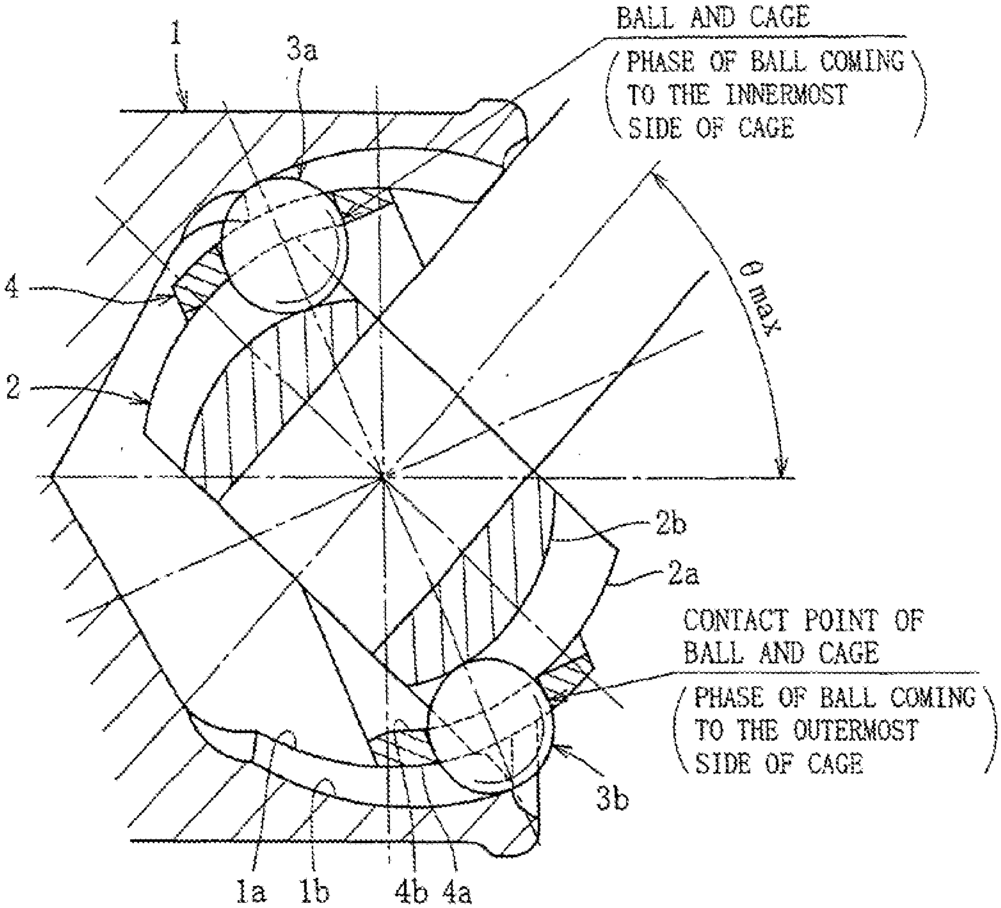

CONTACT POINT OF
BALL AND CAGE
(PHASE OF BALL COMING
TO THE INNERMOST
SIDE OF CAGE)
1
3a
4
2
θ max
2b
2a
CONTACT POINT OF
BALL AND CAGE
(PHASE OF BALL COMING
TO THE OUTERMOST
SIDE OF CAGE)
3b
1a
1b
4b
4a

FIG. 1b

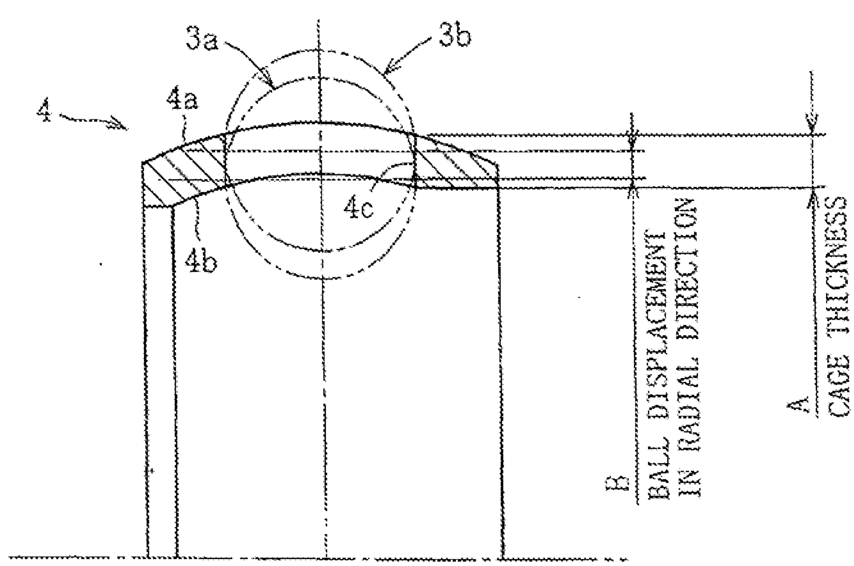

3a
3b
4
4a
4c
4b
B
BALL DISPLACEMENT
IN RADIAL DIRECTION
A
CAGE THICKNESS

FIG. 2a

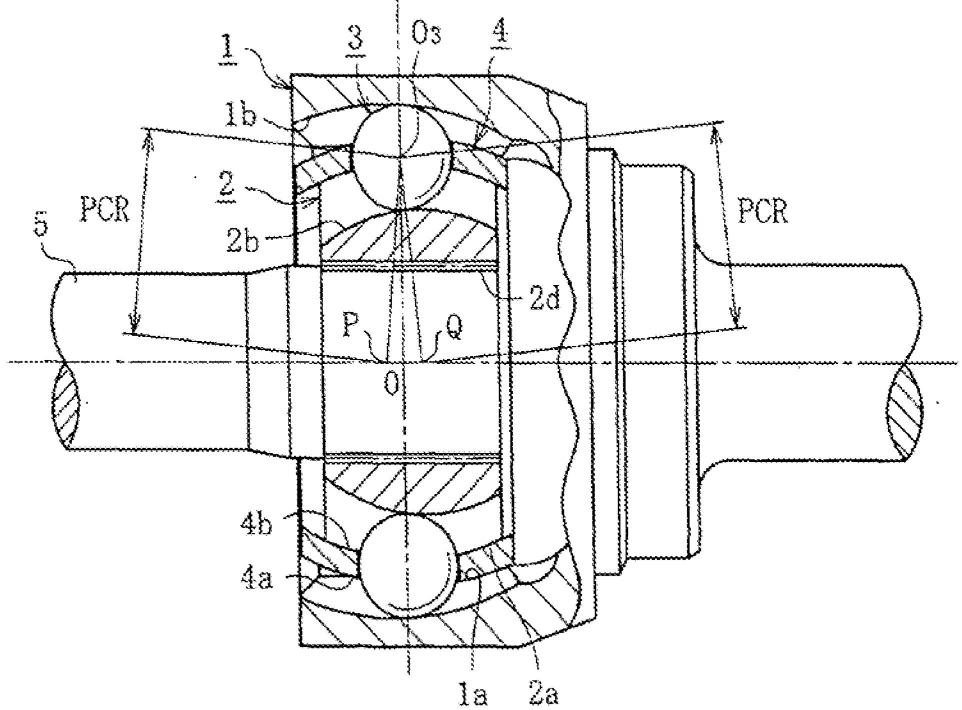


FIG. 2b

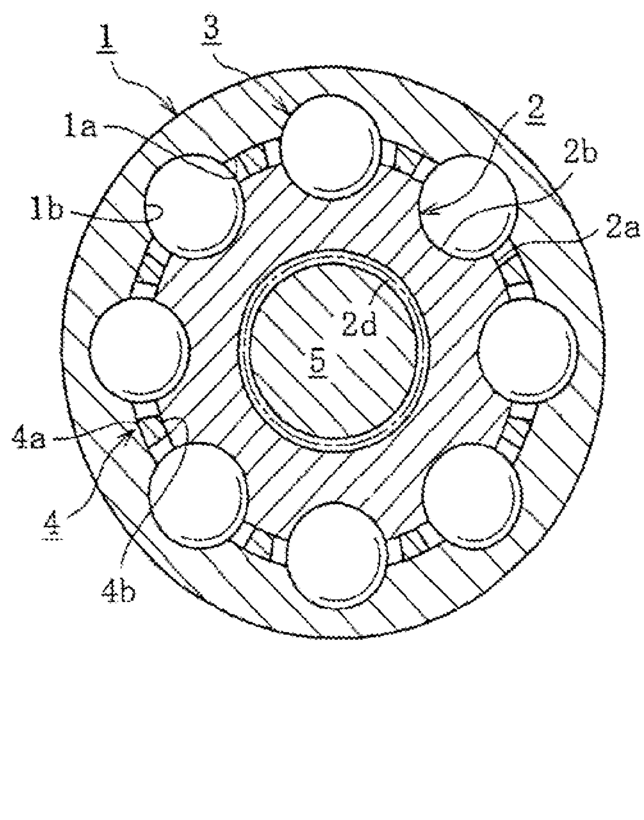
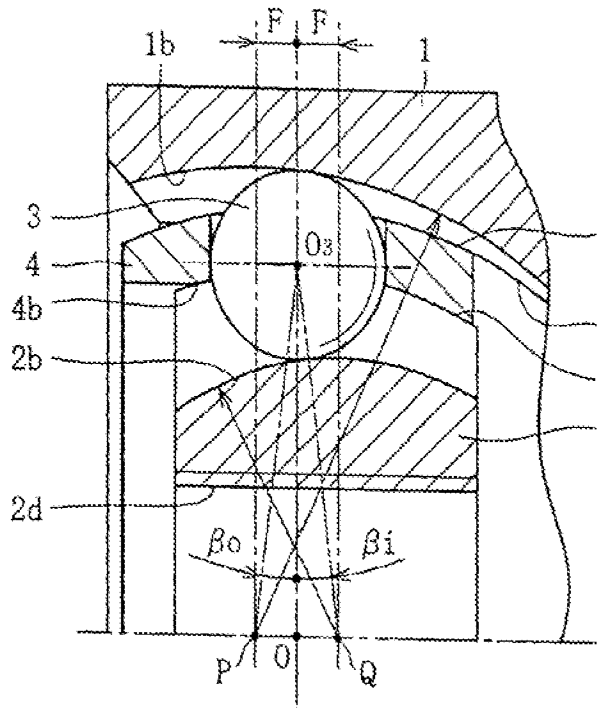


FIG. 3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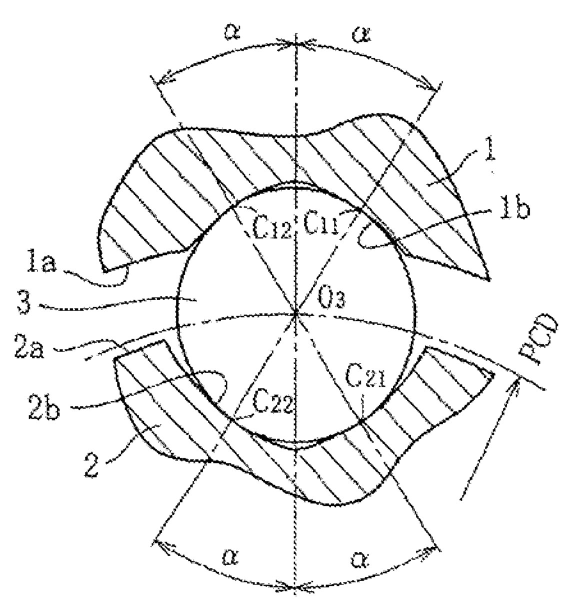
F
1b
1
3
4a
4
O_3
4b
1a
2b
2a
2
2d
βo
βi
P
O
Q

FIG. 4


α
α
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1b
C_{12}
C_{11}
1a
3
O_3
2a
PCD
2b
C_{22}
C_{21}
2
α
α

FIG. 5

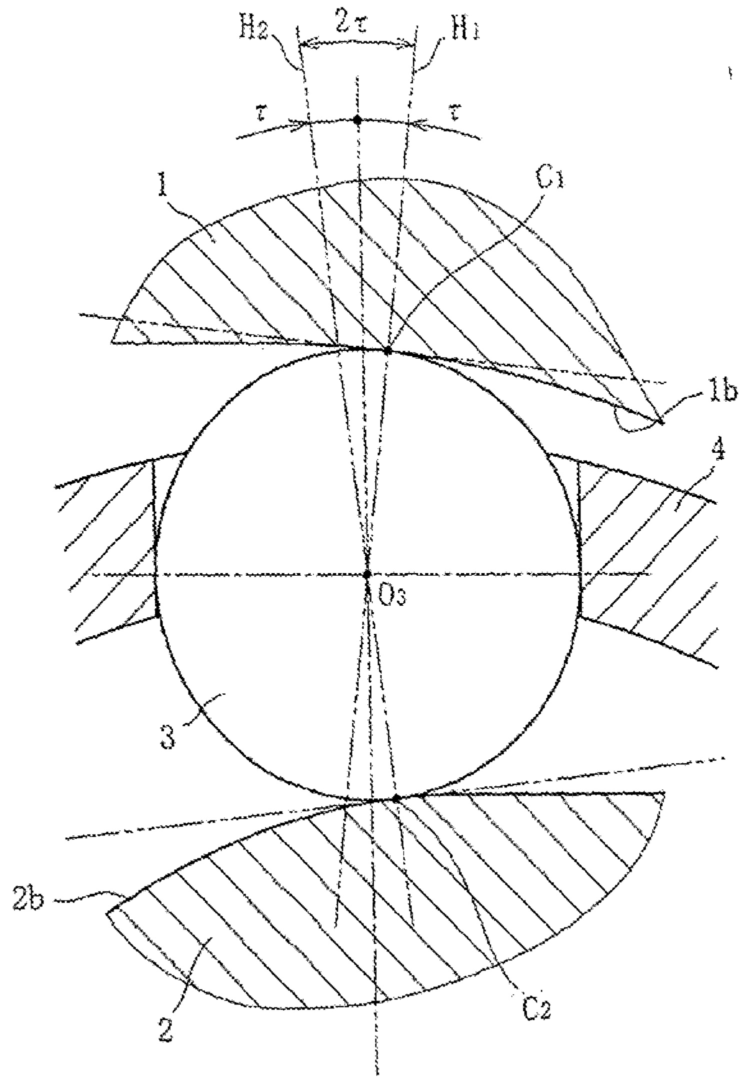


FIG. 6

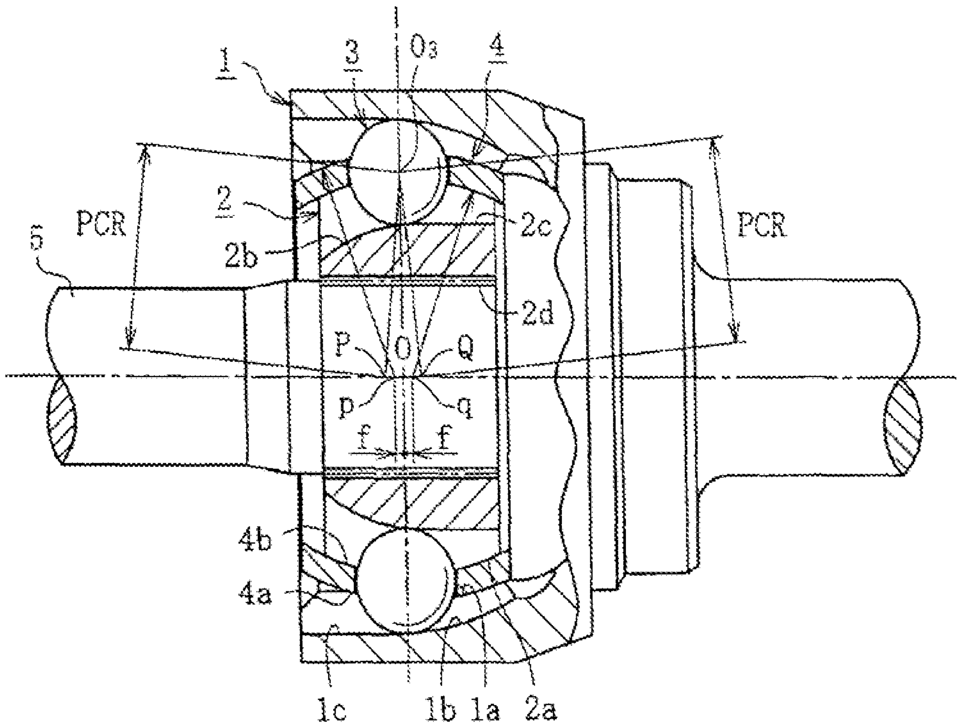

1
3
O3
4
2
2b
2c
PCR
PCR
5
2d
P
O
Q
p
q
f
f
4b
4a
1c
1b
1a
2a

FIG. 7

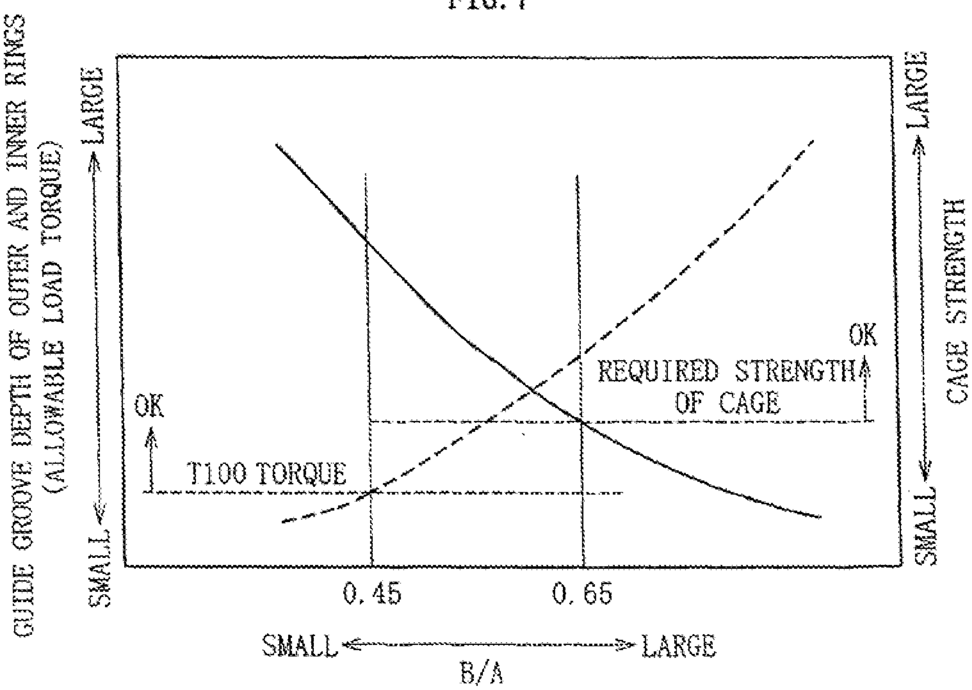

GUIDE GROOVE DEPTH OF OUTER AND INNER RINGS
(ALLOWABLE LOAD TORQUE)
LARGE
SMALL
OK
T100 TORQUE
REQUIRED STRENGTH
OF CAGE
OK
LARGE
CAGE STRENGTH
SMALL
0.45
0.65
SMALL
LARGE
B/A

FIG. 8a

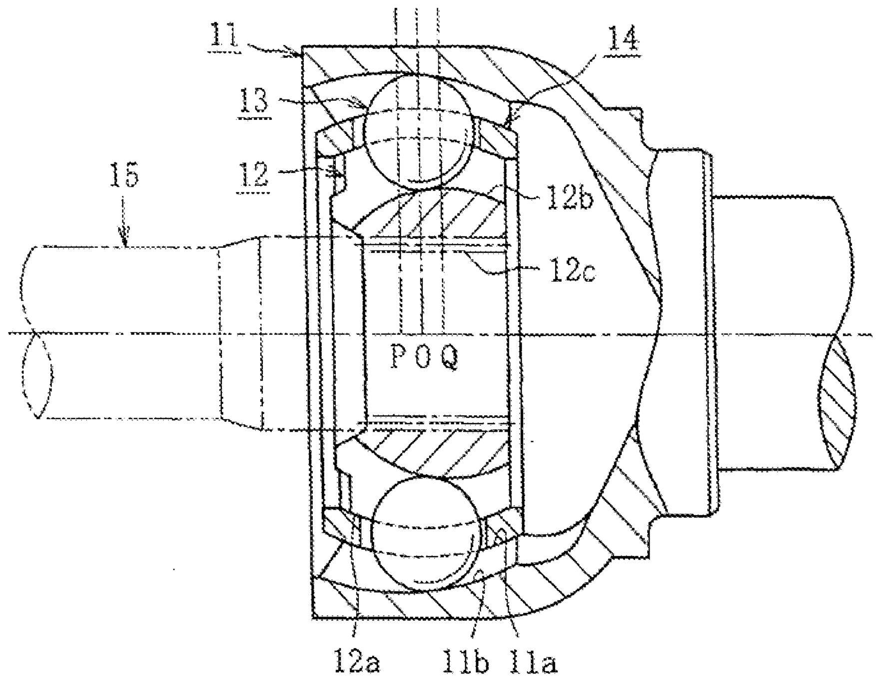
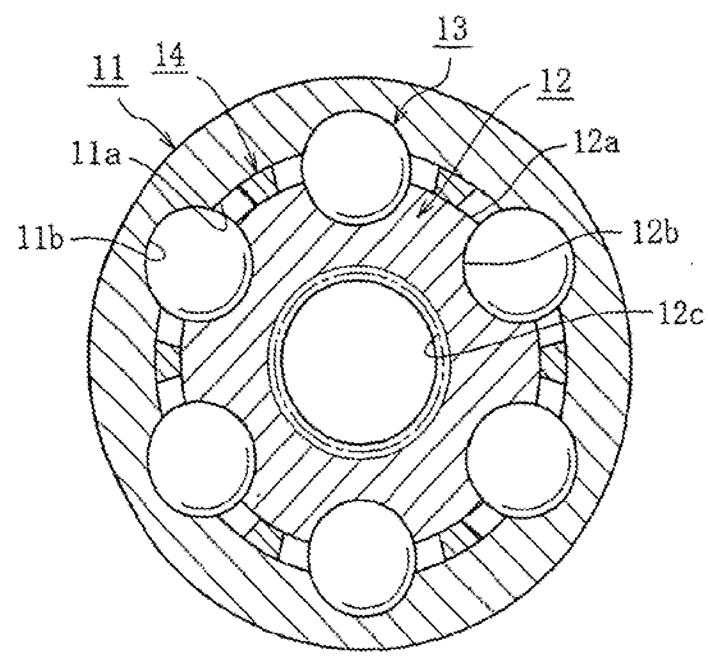

11
14
13
12
15
12b
12c
P O Q
12a
11b
11a

FIG. 8b


13
11
14
12
11a
12a
11b
12b
12c

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 00 1115

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2002/032064 A1 (HOZUMI KAZUHIKO ET AL) 14 March 2002 (2002-03-14) * paragraph [0021]; claim 4; figures *	1-4	INV. F16D3/224 F16D3/223
D,X	& PATENT ABSTRACTS OF JAPAN vol. 1998, no. 04, 31 March 1998 (1998-03-31) & JP 09 317784 A (NTN CORP), 9 December 1997 (1997-12-09) * abstract *	1-4	

			TECHNICAL FIELDS SEARCHED (IPC)
			F16D

The present search report has been drawn up for all claims

3

Place of search	Date of completion of the search	Examiner
Munich	21 February 2007	Foulger, Matthew

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US 2002032064 A1	14-03-2002	NONE	

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